High Temperature Materials Laboratory

Magnesium for Heavy Truck Applications

Background

Lighter-weight materials are being explored to increase the fuel efficiency of Class 8 trucks by replacing their heavier counterparts. A carbon fiber/magnesium composite, for example, is one-third the weight of aluminum. With this in mind, GS Engineering and Oshkosh Truck Corporation are part of a team that is developing truck components from magnesium metal matrix composite (MgMMC) materials. Such materials are prepared using a direct "squeeze casting" technique, in which carbon fiber performs are infiltrated with Mg.

However, in order to transfer MgMMC materials to vehicle component designs, their properties must first be understood. Thus it is important to know the interfacial reactions that take place at the fiber and Mg interface of the composite.

Technology

Research at the Oak Ridge National Laboratory (ORNL) has aided in the understanding of the reactions and effects of the reinforcements in the MgMMC. The microstructure of a carbon fiber-reinforced Mg alloy matrix (AZ91D) composite was characterized at the High Temperature Materials Laboratory (HTML) with the Phi 680 scanning Auger Nanoprobe (SAN). This instrument uses an electron beam in scanning mode to eject low energy electrons from the surface of the composite. The electrons can then by analyzed with a spectrometer to identify the chemical elements present in the composite's upper surface layers.

A high resolution secondary electron image of a polished sample (Figure 1) shows the morphology of the carbon fibers in the Mg alloy matrix. It also displays the presence of a reaction layer at the interface. The numbered spots on the figure indicate the locations and sizes of areas that were analyzed for elemental composition.

Electron spectra (displayed on the following page, in Figure 2), were collected from the analysis points to identify the elements present in the various phases of the microstructure.

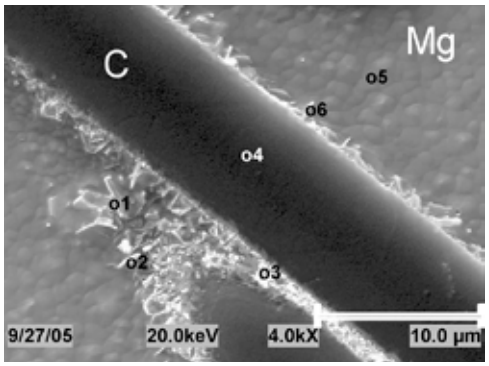

Figure 1. *A high resolution secondary electron image of a polished sample of the composite.*

Benefits

- The materials characterization at HTML provided useful data on the properties of MgMMC materials, which will help enable researchers to improve these materials for truck component design.
- Improved Mg alloy composite materials will contribute significantly to heavy truck weight reductions, therefore improving fuel economy.

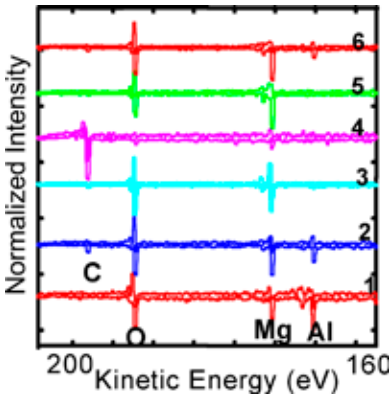

Figure 2.

of the locations of these various elements (Figure 3) showed the interface phase to be oxide rich.

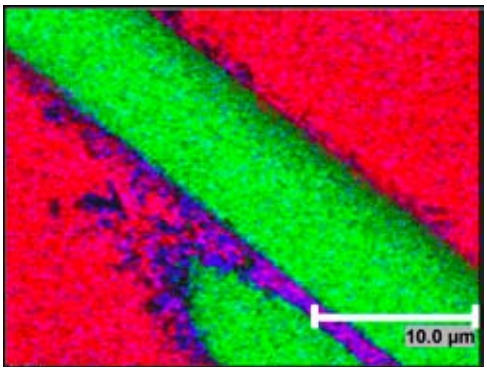

Figure 3.

Fiber cross sections (Figure 4) also show the reaction phase at the fiber-alloy interface.

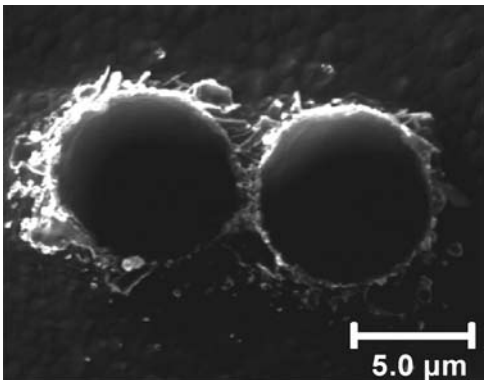

Figure 4.

Based on the SAN analysis, the interface oxide appears to be aluminum-rich (Figure 5). A significant diffusion of Mg into the carbon fiber was also revealed.

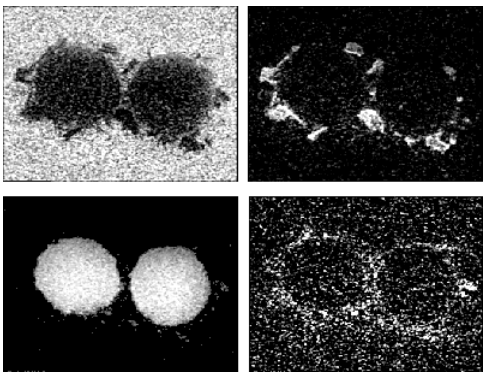

Figure 5.

Status

The results obtained in this project are immeasurable in their value to understanding how to improve MgMMC materials for truck component design. This materials characterization will provide direction for future MgMMC materials use, and because they are significantly lighter-weight, their implementation in heavy trucks will help improve fuel economy.

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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.